TRUSS WARNING SIGNS CAN HELP IMPROVE FIREFIGHTER SAFETY

EXECUTIVE LEADERSHIP

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ABSTRACT

New construction can be found in every community, including Bangor, Maine. With the pressure of job deadlines, rising material cost, and the demand for large open rooms many builders are turning to truss construction to satisfy their customer's expectations. The increase usage of lightweight wood truss roof and floor structures have increased the hazard of injury from structural collapse to the unaware firefighters. Once the structure is completed, it is nearly impossible for firefighters to recognize a building of truss construction. The problem this created for the Bangor Fire Department was no database existed from which to identify buildings of truss construction.

The purpose of this research project was to determine if the Bangor Fire Department could improve firefighter safety from developing and instituting a truss identification program. A descriptive research methodology was utilized to answer the following research questions:

1. What are the inherent dangers of truss construction to firefighters?
2. What methods are used by the fire service to identify buildings of truss construction?
3. What kinds of sign programs have been employed by the fire service?
4. What is the anticipated cost of instituting a truss warning sign program?

The research included a review of published literature, an Internet search for related articles, and a random truss construction survey.

Several results from the research suggested that safety of the Bangor firefighters could be enhanced by identifying buildings of truss construction. The results of the survey indicated that the

majority of fire service organizations contacted have not addressed the hazards of truss construction. The fire departments that have identified truss construction primarily utilize preplans to inform their personnel of the dangers inherent to trusses.

Based on the research conducted, it was recommended that fire departments locate all the truss roof and floor systems in their jurisdictions. Only the early recognition of a truss system will allow firefighters the opportunity to change tactics thereby increasing the firefighter's margin of safety.

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INTRODUCTION

Current architectural design and building construction practices promote the use of lighter materials. This reduces both the material requirements and overall construction cost. One such practice is the increased use of engineered roof and floor trusses. The use of trusses allows the builder to meet design requirements and job deadlines at reduced cost without compromising structural performance under non fire conditions. With the increased demand for both new housing and businesses, expanding communities are becoming the norm. New buildings that employ truss construction can be found in every community, including Bangor, Maine.

Several communities have experienced the serious consequences that have resulted from neglecting to identify structures of truss construction within their jurisdiction. The National Fire Protection Association (1997) statistic shows that from 1977 through 1996, thirty-three firefighters were killed in 18 incidents where wood truss roofs failed while the fire fighters worked on or below them. The problem this created for the Bangor Fire Department was that no database existed from which to draw this critical information.

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BACKGROUND AND SIGNIFICANCE

The Bangor Fire Department (see the organizational chart, Appendix A) has a long tradition of dedicated service to the community dating back to 1814, when the residents raised fifty dollars for their first fire station. Located in east central Maine, Bangor was known as the lumber capital of the east coast, however, the days of large timber has begun to fade into the local history books, from which these facts were obtained.

In the early 1950s, the truss industry began to emerge as an important segment of the forest products industry. The truss industry experienced slow but steady growth in those early years but in recent years this industry and the associated jobs have seen exceptional growth. The public is demanding engineered wood products like trusses which are being utilized in both residential and commercial construction across the country. Further, information obtained from the Wood Truss Council of America indicated that in 1995 nearly four-billion dollars of trusses were manufactured and an industry estimate is that these numbers will likely double by the year 2000.

Every year firefighters are injured, killed, or just barely escape from failing truss systems. Earlier this year several fire departments within Maine experienced near misses from sudden and complete roof truss failures. These incidents were quickly shared through the local media and members of the Maine Chief's Association where solutions for dealing with incidents involving trusses was being eagerly sought.

The Bangor Fire Department has been recognized as a local leader in the fire service

community. It has expanded its role in numerous arenas; a rapidly expanding emergency medical service, technical rescue unit, dive unit, hazardous materials support team, and an aggressive training division. This caused several neighboring departments to look toward Bangor for a response that they too might embrace.

With a growing number of new construction projects utilizing trusses in Bangor and a truss manufacturer located just outside the community, there was an urgent need to address the issue of identifying these structures. The administrators of Bangor Fire Department were determined to address this issue prior to our community being added to a growing list of national statistics.

This research project addressed the issue of determining the appropriate steps to institute an effective truss identification program through developing and utilizing influence skills.
This issue was analyzed in the Executive Leadership Course (unit 5), at the National Fire Academy. Faced with the potential impact that a failing truss system could bring, the Bangor Fire Department needed to develop a responsible method to identify buildings containing truss construction. This paradigm shift would require the development of a strategy that would solicit responses from other fire service organization without seriously alienating builders or the truss manufactures. This strategy would also need to address a method of implementation that would insure compliance. It is anticipated that the resolution strategy developed for the Bangor Fire Department's administrators could be generalized for application in other departments faced with the issue of identifying structures of truss construction.

LITERATURE REVIEW

The data reviewed for this project involved the examination of literature pertaining to trusses from three general subject areas. First, literature on roof and floor trusses was reviewed as it pertained to the building industry. This body of articles was examined to obtain insight into the influence trusses have on the construction industry. Second, literature on the hazards of trusses was reviewed to determine the potential impact they have on the fire service. Finally, fire service literature was reviewed to determine what other jurisdictions had experienced in implementing a truss identification program. This material was examined to seek guidance from the successes and failures of other fire service organizations.

The Influence of Trusses

In an article taken off the Internet, Kirk Grundahl, PE (1998) provided the Wood Truss Council of America's (WTCA) answers for developing and utilizing lightweight trusses.

> Being environmentally responsible also means utilizing our raw materials as efficiently as we can. Trusses are engineered to use our forest resources efficiently. Trusses, I-joist, and laminated veneer lumber products have evolved with the design in mind to efficiently utilize wood fiber, resulting in less cutting and less waste of trees needed to manufacture them (p. 4).

This statement reinforced the importance that trusses have to both the building industry and forest management.

Some authors were in agreement that the cost savings remains the primary focus of builders

using trusses. The use of lightweight framing members can materially decrease the building's cost to the owner (Fornell, 1995). Susan Bady (1999) suggested that wood trusses are economical construction elements that combine high strength, lightweight, and cost savings to the builder. Robert Malanga expressed a similar view. Wood truss construction is desirable because of the decreased cost in terms of construction and labor, primarily due to their weight (Malanga, 1995).

> Malanga (1995) also described how the cost saving of trusses are recognized by the builder. The open spaces in the webs of trusses allow plumbers, electricians, and HVAC installer to pass utilities, ductwork, piping, and conduit through the trusses without drilling or otherwise weaken the structural members. Prefabricated, pre-designed wood trusses also allow builders to span larger areas and generally, may be installed at larger, on-center dimensions than conventional solid wood joist and rafters (p. 45).

It appeared that cost savings and maximum utilization of resources are some of the influences that promote the use of wood trusses.

The trusses used in building construction can be made of wood, metal, or a combination of both materials. Both the shape of the trusses, as well as the size and type of the material used to make the trusses affect the performance of a truss under fire conditions (NFPA, 1997).

The Impact of Truss Construction

Two noted experts share the same opinion of truss construction. From a fire service viewpoint truss construction is the most dangerous roof system that a firefighter will encounter (Brannigan, 1999). It is known to collapse during the early stages of a fire, and it will often cause the subsequent collapse of the front masonry enclosure wall of the structure (Dunn, 1988). From a collapse standpoint, the most

dangerous roof rafter system is the truss. If one truss suddenly collapses, a large area or the entire roof may collapse as well (Dunn, 1992).

In a recent article Vincent Dunn (1998) stated that not all firefighters recognize all the dangers inherent to truss construction:

> Most firefighters are aware of the dangers of operating on a truss roof and falling through. Most firefighters are attuned to the dangers of operating inside a burning truss roof building and being crushed beneath a collapsing truss roof and ceiling. However, very few firefighters remember the third kind of deadly truss roof collapse, operating outside the building and being killed when the masonry walls collapse simultaneously with the roof
>
> (p. 19).

Dunn pointed out that in timber truss systems, the walls receiving the sloping hip rafters can be pushed out during a truss roof collapse and bury firefighters operating outside the building (Dunn, 1998).

Fire is not the only factor that weakens the structural integrity of trusses. During the construction phase, if trusses are not properly inspected, installation deficiencies may go unnoticed and, ultimately, lead to premature assembly failure during a fire (Malanga, 1995).

Vincent Dunn (1988) also expressed concern in this area:

> The lightweight wood trusses are prefabricated at a factory and shipped to the construction site, where they are stored until needed. If these trusses are improperly transported or stored at the site, or if they are dropped or handled roughly, the metal surface fastener can pull away from the wood surface or become loosened. In this instance, the truss has been weakened even before it is installed in the building (Dunn, 1988).

The possibility of weaken trusses failing early in a fire was substantiated in several post fire investigations. Curtis Massey (1996) stated that in one investigation while the building was under construction and just as the wooden sheathing was about to be applied to the exposed trusses, the trusses began to collapse in a domino effect and injured three construction workers. This may have resulted in an inherent weakness in the construction, which may have contributed to the rapid and possibly premature collapse of the entire roof assembly early into the fire (Massey, 1996).

Firefighters cutting into a roof supported by lightweight trusses may inadvertently sever the top chords of the trusses or portions of the web critically weakening the system. If enough cuts are made in the same truss chords, the entire system may fail (Malanga, 1995).

There are a greater number of connections in a truss and, if any one fails during a fire, it can trigger the entire truss to collapse (Dunn, 1988). Dunn explained his reasoning for expressing concern about the connecting points:

> One of the main concerns of the fire service is the sheet metal surface fastener used to connect the truss members together. The surface fastener, which only connects the outer one-half inch of wood truss members, is a deficient structural connection from a fire protection point of view. The design of the truss can be defended from an engineering viewpoint, but no architect, engineer, building construction contractor, or code official can defend the sheet metal surface fastener. This device is a dangerous structural connection (p. 148).

Robert Malanga (1995) explained that one of the problems associated with manufactured wood trusses is the improper installation of nailing or gusset plates. Malanga went on to explain that a gap of 1/6 inch between the gusset plate and the wood can reduce connection strength by up to 50% (Malanga, 1995).

In his book on "Safety and Survival on the Fireground" Vincent Dunn (1992) expressed his concern of the large surface-to-mass that the smaller framing members create:

> Truss construction provides a dangerous roof or floor design when exposed by fire. The large surface-to-mass ratio of the many small interconnected truss members make the structure vulnerable to early collapse (p. 112).

The presence of literally hundreds of lightweight framing members added to the intensity and hence, the speed of the fire spread (Fornell, 1995).

Another issue raised by several authors was not only the trusses themselves but the large void area they created. In truss construction the inherent voids permit a large volume of fire to develop throughout the whole void space (Massey, 1996). Since a truss void is so open, it can allow a fire to simultaneously expose a larger portion of structural members than a conventional solid wood joist void would (Malanga, 1995).

Several of the published post collapse investigations revealed that the collapse provided no warning. It is possible to have a serious fire in the roof void with little or no smoke visible in the building (Massey, 1996). Collapse in structures constructed of lightweight framing comes quickly, gives no warning and usually causes widespread damage (Fornell, 1995). There was no indication of what was going to happen (Delia, 1999). The firefighters indicated that at no time did any of them feel any excessive heat or see any fire prior to the collapse (NIOSH, 1998). In many cases of collapse in which firefighters were injured or killed, little smoke or other indication of fire was present before structural members gave way (Fornell, 1995). The sudden collapse of the roof trusses eliminated any chance of escape or rapid rescue (Massey, 1996). Statements similar to those included herein were found in most

of the investigative after action reports.

The Implementation of a Truss Identification Program

A key factor was that with many of these structures, it was nearly impossible to see from the ground level that the building contained a wood truss roof (MacIsaac, 1995). According to Vincent Dunn (1988), recognizing a building is constructed with trusses is not an easy task:

> It is not always possible during a fire operation to identify a building having lightweight wood trusses. To safeguard the firefighters at a structure fire from collapse of any type of truss, everyone must be aware of the presence of the truss in the building (p. 151).

Vincent Dunn also suggested that the early identification of a truss is the key to a safe operation. When the truss is identified early, serious injury can be avoided by using a defensive strategy (Dunn, 1988).

There are several authors that have expressed the importance of preplans that identify the presence of trusses. Each structure should be pre fire inspected to determine interior design and type of materials used in construction (NIOSH, 1998). Firefighters must go out in the field to examine building construction in their response areas (Kopp, 1998). Have your units get out and locate trusses, marking them on preplans (Brannigan, 1999). An important step is to identify lightweight truss structures within your response district (Fornell, 1995). Record all buildings with truss roofs into the Critical Information Dispatching System (CIDS) program (Dunn, 1998).

Vincent Dunn's (1988) book on "Collapse of Burning Buildings" pointed out that a firefighter's knowledge of building construction not only assists him in fire extinguishment, but it increases his chances of survival. To operate safely on a roof, a firefighter must first know the type of roof rafter support system that is holding it up (Dunn, 1992). Francis Brannigan (1987) shared a similar view in his

book.

> All too often truss constructed buildings gives no outward indication of its presence. The only solution is for the fire department to preplan, record, and be able to retrieve on the fire ground the information on the construction (p. 58).

But currently, not all fire service organizations have the ability to retrieve the critical information on the building construction in a timely fashion.

Keith MacIssac pointed out a concern with relying on preplans as the only source of identifying truss construction:

> The vast amount of available information from preplans cannot be easily digested by the incident commander during the early phases of the fire ground operations, nor can it be readily reviewed by responding personnel before their arrival on the scene (pp. 24).

Glenn Corbett (1998) pointed out that after the Hackensack fire that claimed five lives, many investigations were conducted. One tangible outcome was a requirement in New Jersey for the placement of placards on buildings, identifying them as truss construction. This view was also shared by Howard Woodbury (1998) when he explained how preplans and truss identification placards required by New Jersey state regulations saves lives (Woodbury, 1998).

The intent of a truss warning sign is to provide a visual reminder to command personnel of the type of roof the structure has and to remind them to reevaluate the general operations plan occasionally (MacIsaac, 1995).

The time to develop a plan of action for fires involving lightweight truss framing is before the structure is built, by insisting on a strong set of codes that help ensure the safety of the building's

occupants as well as responding firefighters (Fornell, 1995). Preplanning by first-due companies is critical, especially identifying the type of building construction. Recognition of the hazards of lightweight truss construction and the inherent void spaces they create will reinforce the critical factors of time spent in the structure and the expectation of rapid structural failure (Massey, 1996).

In summary, the literature revealed that truss identification is undeniably linked to firefighter safety. Articles suggested that the early recognition of truss construction can allow incident commanders adequate time to review strategies and modify their tactics. Several articles suggested that the survival of a suppression force, may depend on their ability to adjust tactics to reflect the constantly disintegrating conditions of a burning structure. Only the organizations that have taken a proactive role in addressing the hazards of trusses in their community are adequately prepared for a confrontation with this building system. The same articles expressed concern that without a trust identification program in-place, many organizations are insufficiently informed of the type of building construction that is hidden from their view. Most articles indicate that overlooking truss construction may jeopardize the ability of the organization to recover in time to avert a disaster. Many authors are convinced that the impact of failing to develop a truss identification program may open the door for organizations to enter into the arena of litigation.

In review of the articles dealing with the fire service community most indicate that having a strategy to address truss construction is critical. Clearly, most articles expressed concern that the best way to insure safety of the firefighters was by preventing negative outcomes from ever occurring. The articles suggested the most effective programs for truss identification is the use of preplans and warning signs. A consistent theme through all the articles was the need for a proactive program, which will

provide a clear vision to the firefighters of the hidden hazards the building contains.

PROCEDURES

A review of the literature on lightweight wood trusses, truss construction, and related fire-based building construction articles, comprised the first stage of the research procedure. The literature review was conducted using a descriptive research methodology. Literature reviews were conducted using the research facilities at the University of Maine at Orono, Maine, the Bangor Public Library in Bangor, Maine, the Maine State Library in Augusta, Maine, and the Learning Resource Center at the National Emergency Training Center in Emmitsburg, Maryland. Request were also submitted to the National Association of Fire Chiefs, the International Association of Firefighters, the National Fire Protection Association, the U.S. Fire Administration, and the National Institute for Occupational Safety and Health for articles focusing on firefighter fatalities and injuries related to truss construction. In addition, several journal articles and research papers were identified as having relevance to this paper. The Internet was searched for articles on truss construction and firefighter safety. Further, a search was conducted of recent articles (within the last four years) in issues of the fire service and building construction trade journals pertaining to truss construction.

The articles identified through the literature search were reviewed and analyzed. Those deemed pertinent were summarized for inclusion in the literature review section of this paper.

A truss identification survey was randomly distributed to fire service organizations represented at the National Fire Academy, recently attended conferences, and through previously obtained contacts.

A survey sheet (see truss identification survey sheet, Appendix B), was distributed to all the students present at National Fire Academy and the Emergency Management Institute during the last week of March 1999. The survey sheet was circulated to those attending the International Association of Firefighter's emergency medical services conference in San Francisco, California, May 4-9, 1999. The survey was also distributed to those connected with the fire service at the International Association of Arson Investigator's conference in Las Vegas, Nevada in May 17-21, 1999. Survey sheets were also mailed to individuals taken from previously attended NFA class rosters in states not previously contacted. In a three-month period a total of 1,500 surveys were distributed with 1, 333 being returned. Organizations were contacted representing all fifty states, however, responses were only received from agencies located in 47 states. The results were calculated by question and are listed in Appendix E.

Limitations

This research project faced several limitations that affected the outcome. First, there is no standard fire service definition for the term "collapse." With the absence of an accurate, standard definition of the term "structural collapse," there has been an under estimation of the truss collapse problem.

Despite the potential danger to firefighters from sudden collapse, there is very little information about the subject in the fire service. There is almost never a record or written report of a collapse unless several firefighters have been injured or killed making the collapse an issue of national interest. Simple questions such as "type of construction" are often unreported and when it is, all too often it's nonspecific. This was apparent in reviewing the incident reports where the construction characteristics

of the roof and floor assemblies were not reported. Without clear and concise data available on the cause of firefighter injuries specific to the type of construction, many incidents were removed from consideration that may have impacted this research paper. This was identified as the second limiting factor that had to be overcome.

The third limiting factor resulted from the legal consideration that evolved when someone is killed or injured at a fire. The officials in charge of the investigation are often concerned only with placing blame. Valuable information about structural collapse danger and safety lessons that could be provided firefighters is often overlooked and lost during the investigation.

Another limiting factor was outside political pressure. When the dangers that truss construction presented to firefighters was pointed out to the council a response was filed by the truss manufactures. Although the truss manufactures were too late to prohibit Bangor's "Truss Ordinance" (see truss ordinance, Appendix C) from adoption they turned out in force to speak in opposition of the proposed State of Maine legislation (see "An Act to Improve the Safety of Firefighters, Appendix D) that was pattern after Bangor's ordinance. This resulted in the legislation's sponsor withdrawing this legislation prior to coming to a vote until after the summer recess.

Definition of terms

Gusset plate A stamped metal plate with raised teeth that is embedded in lightweight wood truss joints at the panel joints to hold the individual truss members together. The gusset teeth usually penetrate the wood members approximately 3/8 inch.

Lightweight truss Incorporates wooden members which can be as small as two inches wide and four inches deep. These wood pieces are connected by sheet metal surface fasteners called gusset

plates or gang nails.

Panel joints Connections of struts, ties, and cords in lightweight wood trusses.

Parallel chord truss A typical floor truss that consist of two straight, parallel chords at the top and bottom, connected by a diagonal framework of smaller web members of either metal or wood.

Timber truss In heavy timber trusses the wood dimension is at least four inches wide and six inches deep, connections and fastenings used to connect web members and chords of are made of steel plates with bolts.

Triangle Given three lines with all ends touching only one shape can be formed the triangle. The only rigid geometric form, the triangle is inherently stable. As the only rigid geometric form the triangle is inherently stable.

Truss A structural building component composed of relatively lightweight individual members joined together in a group of triangles, that work together to support loads over a relatively large spans. Trusses are inherently rigid, use material more efficiently, and have little excess and redundancy.

Struts Compressive connecting members of a truss.

Ties Tensile connecting members of a truss.

Web As a group, the struts, ties and panel joints that connect the cords together.

RESULTS

At the onset of this research project, four specific research questions were identified. The results of the research are organized around those four questions and presented in order:

1. What are the inherent dangers of truss construction to firefighters?

The literature suggested that the use of truss construction is widely used in the construction industry. In nearly every community in America some type of trusses can be found. Most of the literature documented actual incidents where firefighters have been injured or killed by failing truss systems. It was suggested in the literature that the actual danger to firefighters may be underestimated since many of the near misses are never reported. Furthermore, the literature indicated that the increase use of trusses translated directly into an increased inherent risk to the firefighters working in, on, and outside these systems.

2. What methods are used by the fire service to identify buildings of truss construction?

The literature review suggested that the use of preplans are widely used by fire service organizations to identify truss construction in targeted buildings. It was also indicated in the literature reviewed that few communities have instituted a program utilizing either placards or signs to augment their identification program. Results of the random survey (see summary of the truss survey, Appendix E) indicated that most of the communities that have a method in place use preplans to identify their buildings of truss construction. The survey also indicated that the majority (67%) of the respondents do not have a system in place which is illustrated in Table 1.

TABLE 1
(Ratio of Communities with/without Truss Programs)

Response to:	**Total Respondents**	**Yes**	**No**
Community has program	1333	493	840

Table 1 clearly illustrates that the majority of the respondents indicated they do not have a method in place that identifies buildings of truss construction. These results were unexpected given the number of tragic incidents and articles warning of the importance of early recognition of structures containing trusses.

Table 2 provides an overview of the responses received from those that indicated their community has a method in place to identify buildings of truss construction.

TABLE 2
(Method used to Identify Truss Construction)

Response to:	**Preplans**	**Signage**	**Other**
method used	449	16	28

Table 2 illustrates that out of the 493 respondents indicating their community had a method of identifying buildings of truss construction that 97% used preplans. The survey indicated that only 37% of the respondents have a system in place to identify trusses and only 3% of those have a system that utilize a warning sign. Clearly the majority of respondents that have a system in place depend upon preplans to identify their buildings of truss construction.

Twenty-eight respondents marked "other" as their method of truss identification. It should be noted that eight of these respondents indicated they use an onboard computer data system. Five

respondents indicated their community utilizes a CIDS dispatching system and the remaining 15 did not specify their method used.

3. What kind of sign programs have been employed by the fire service?

The literature review suggested that most fire service organizations do not employ a warning sign program. The results of the random survey (Appendix E) fully supported this concept. Table 2 illustrates that out of the 493 respondents, indicating their community had a method to identify buildings of truss construction, only 16 communities indicated that signs were part of their program. It should be noted that of the 16 communities, 11 were from various departments within the state of New Jersey. The literature review indicated that there is no uniformity in the design of the warning signs. The literature suggested that only New Jersey has adopted a state wide program that insures some consistency within their state. The remaining five communities have elected to institute their own programs which are varied as to the type, design of the warning sign, and actual scope of their programs. This was evidenced in the survey results that are illustrated in Table 3.

TABLE 3
(Information Provided by Warning Sign)

Differentiate/*Applies to*	**Yes**	**No**
roof / floor trusses	4	12
wood/steel trusses	4	12

commercial/industrial	16	0
multi family	10	6
residential	4	12
all types	1	—

Table 3 provides a breakdown of the responses taken from the 16 survey sheets of those utilizing a warning sign program. It is evident from the data collected that there is no national uniformity in the approach taken by the various departments outside the commercial/industrial category.

4. What is the anticipated cost of instituting a truss warning sign program?

In answering this question, the research established that there were several factors that could influence the anticipated cost of a truss warning sign program. The identified factors included, the type of program, the scope and magnitude of the program, the type of sign used in the program, and the actual cost of administering the program. There was also the issue of uniformity of the signs and insuring compliance to the truss warning sign program.

The Bangor Fire Department's annual budget is funded through the city's tax base. Since the department had not initially budgeted for a truss sign program, the startup cost was needed from the general fund. However, with the city council's policy of holding taxes in check and restricting new programs it was decided that an alternative source of funding would be advisable. Department administrators decided to look internally for the funding to initially start the program and to then sell the

new program to the council after a successful implementation.

To establish the anticipated cost of the truss warning sign program each of the identified factors needed to be considered. The first item to be considered was the type of truss warning program. It was decided that the program would require a small sign to be placed on the exterior of every building containing truss construction (see truss ordinance, Appendix C). This would require signs to be developed, made, distributed, and inspected.

The second consideration was the scope and magnitude of the program. Some departments that have instituted a truss warning program use it to identify a specific type or class of buildings such as commercial, industrial, multi family, or residential. The Bangor Fire Department's administrators considered all trusses as potentially hazardous to firefighters. It was decided by the administrators and approved by the city council that an ordinance should be developed that would require truss warning signs on all buildings that utilized truss construction.

After defining the scope of the program an identifying sign needed to be selected. Several types of signs were considered and the final choice was a silver aluminum 4"x 5" sign with a black anodized "T". The sign would include an emblem of a truss above the "T" for structures with roof trusses, below the "T" for floor trusses, and both above and below in structures that employed both systems (see truss signs, Appendix F). This program required stocking three specific signs. It was determined that a minimum order of 75 signs be made at an initial cost of approximately $11.00 per sign.

Fire department administrators set a charge of $15.00 for each sign required for a given structure. The actual cost was to be added to the building permit fee. Inspection to insure compliance was assigned to code enforcement/fire prevention personnel tasked with issuing the certificate of

occupancy. With the administrative duties being tasked to those already dealing with the builders no addition cost were incurred by the city other than the original first time purchase.

The anticipated cost of instituting the truss warning sign program was determined to be $1,075.00. This included $825.00 for the signs, $200.00 for the instructional brochures, and $50.00 for an initial advertisement of the new ordinance. This could be recognized as a short term cost. Net proceeds from the sale of the 75 signs would yield $1,125.00 making the program self sustaining. Further saving could be anticipated since all future orders for signs would not include the first time setup cost. This translated into no appreciable impact to either the fire department or city's annual budgets.

DISCUSSION

The literature review established that truss construction has been and will remain a vital component of the building trade industry. It also reaffirmed the tremendous hazard that trusses present to the unwary firefighters. The only question that remains to be answered was what method of truss identification should each fire department use? For the Bangor Fire Department, the answer was fairly easy. The safety of the firefighters demands our attention to satisfy the need of identifying buildings of truss construction.

Many communities have a substantial investment in their local fire department for apparatus, equipment, personnel, and training. When an emergency does occur, the citizens call 911 with the anticipation that the fire department will quickly respond and professionally handle the emergency at hand. They expect and deserve quality service for their trust and sizable investment. The firefighters

also have reasonable expatiations that must be met. They deserve competent and informed fire ground officers that will seriously consider every possibility that improves firefighter safety. The idea of the truss warning sign developed from a concern that company officers could use a device to help them identify truss construction. A warning sign is a simple tool that can serve as a visual reminder to command personnel of the presence of trusses. This tool can allow commanders the time to modify tactics thereby improving firefighter safety.

A NIOSH report suggests that:

> One of the most important size-up duties of the first arriving fire officers is locating the fire and determining its severity. Of equal importance and often overlooked is the type of building construction, its inherent influence on the fire and the deterioration of the structure (pp. 6-7).

This researcher discovered, as a result of this research, that most fire service organization's truss identification programs were in direct response to an incident that directly impacted their department. It became apparent from the research process that if the Bangor Fire Department was to remain a pro-active fire service organization they would need to institute a truss identification program. This presented the department administrators with the task of sifting through the methods utilized in other organizations to determine the best program for Bangor. Department administrators believed that through a truss warning sign program the organization would achieve a greater level of safety for their firefighters and lessen the liability to their taxpayers.

While the issue of truss warning signs came under fire from the truss manufactures, the Bangor Fire Department was developing a strategy that would ultimately lead to the successful development of their program. The Bangor Fire Department took the position that included a structured program that

mirrored and enjoined the best concepts of the programs identified within the research process. This focus allowed the administrators to develop a program that was both feasible and attractive to the other fire service organizations in the state.

This researcher discovered, as a result of this research, that the clear vision is one unobstructed by preconceived ideas and being well informed of the full range of possibilities an issue presents. In dealing with the issue of firefighter safety the plan must not be cast in stone but must remain flexible and provide for a contingent plan to be implemented at a moment's notice. Although there has been broad-based support from the state's fire service organizations for the new truss warning sign program, few evidently fully understand the implications and are willing to commit their full energies into developing their own program. Many have decided to wait for the state to mandate a program rather than take charge of their own department's destiny. Furthermore, as the truss program develops and problems are identified, fine tuning will be required to insure the overall success of the program.

RECOMMENDATIONS

This study supports the need for fire service organizations to develop a system to identify the buildings in their community with truss construction. This researcher agrees with these facts and recommends the following steps to meet these objectives:

Organizations should develop a program that identifies buildings of truss construction that will work for their community. The chosen program must allow for quick and immediate access to critical data by first due fire crews. The time and energy devoted to gathering the necessary information is time well spend, and may result in shared vision of ownership in the established program by the fire crews.

Establish an ordinance requiring all structures constructed with trusses to be identified with a truss warning sign. For the warning signs to be effective, they must be uniformly applied on all truss structures. Voluntary compliance will not insure the fire service that all truss buildings have been identified. The issue of firefighter safety can only be adequately addressed through a mandatory program that requires building owners to comply. Open communications, public awareness training, and educational support for builders and owners will substantially enhance support prior to implementation of truss warning sign program.

Develop a training program to be delivered to all fire suppression personnel on basic fire ground strategies and tactics for varying building types. Each type of construction should be reviewed with special emphasis on truss construction and on the implemented truss warning sign program.

Encourage other fire service organizations to look at their method used to identify truss construction. Look for opportunities to support your program of firefighter safety by enhancing the truss warning sign program. When structures of truss construction are identified, motivate owners to embrace the program through compliance to the established ordinance.

The Bangor Fire Department should continue to review the input received from the public and fire service personnel, adjusting the program as necessary. Develop a data base that can be utilized to insure all buildings with truss construction continue to be identified with a warning sign. Read the Fire Service journals to remain current on changing trends in the building industry that may impact the fire service or firefighter's safety. Train all personnel to understand how the specific program utilized by the department will work and prepare the service to integrate with it. Periodically evaluate and modify the system through fine tuning, until it is an inseparable part of the organization's culture.

In conclusion, fire service leaders need to be visionaries. They need to apply creative management techniques to the fire department by exploring any new idea or in scrutinizing concepts proven by other fire service organizations for possible adoption into their department. A tool to successfully reduce unnecessary risk to firefighters can be as simple as a truss warning sign. This key to success of the fire service organization will be discovered through taking a pro-active approach designed to address the issue of the dangers of trusses. No responsible administrator should sit back and wait until they are forced to act. They should, however, research new ideas and concepts that will enable them to ensure the future of their fire service organization by promoting firefighter safety.

REFERENCES

Bady, S.; (1999). Satisfaction guaranteed. Professional Builder. p.12-14.

Brannigan, F.; (1987). Frank Brannigan tells it like it is. New York: A PennWell Publication. pp. 56-63

Brannigan, F.; (1999, February 15). Two minute warning: Attic fires and trusses. IAFC On Scene. p. 7.

Corbett, G.; (1998, September). Ten miles and ten years. Fire Engineering. p. 106.

Delia, T.; (1999, April). Texas tragedy. Fire-Rescue Magazine. pp. 33-43.

Dunn, V.; (1988). Collapse of burning buildings — a guide to fireground safety. New York: A PennWell Publication. pp. 110-112, 148-151.

Dunn, V.; (1992). Safety and survival on the fireground. New Jersey: Fire Engineering books & videos. pp. 112, 360-361.

Dunn, V.; (1998, 4th). Three kinds of timber truss roof collapse. WNYF. pp. 18-21.

Fornell, D.; (1995, March). Don't trust these trusses. Fire Chief. pp. 43-47.

Grundahl, K.; (1998). Fire performance of trusses reference guide. Wood Truss Council of America. [On-Line]. Available: http://www.woodtruss.com/wtca/fire.htm

Kopp, M.; (1998, March). On the Job: Illinois. Firehouse. pp. 78-80.

MacIsaac, K.; (1995, February). Warning: Risk of sudden roof collapse. Fire Chief. pp. 23-25.

Malanga, R.; (1995, First Quarter). Fire endurance of Lightweight wood trusses in building construction. Fire Technology. pp. 45-61.

Massey, C.; (1996, August). Two firefighters fall in Chesapeake. Fire Engineering. pp. 58-70.

National Fire Protection Association.; (1997, February). NFPA: Alert bulletin, 97-1. p.1.

National Institute of Safety and Health.; (1998, April 27). FACE-97-17:Sudden roof collapse of a burning auto parts store claims the lives of two fire fighters – Virginia. NIOSH Firefighter Investigations. [On-Line]. Available: http://www.cdc.gov/niosh/face9617.html

National Institute of Safety and Health.; (1998, May). FACE-98F-05: Backdraft in commercial building claims the lives of two firefighters, injures three, and five firefighters barley escape – Illinois. NIOSH Firefighter Investigations. [On-Line]. Available: http://www.cdc.gov/niosh/face98F05.html

National Institute of Safety and Health.; (1998, July). FACE-98-07: Commercial structure fire claims the life of one firefighter – California. NIOSH Firefighter Investigations. [On-Line]. Available: http://www.cdc.gov/niosh/face98F07.html

Woodbury, H.; (1998, September). Truss roof fire; Wyckoff, New Jersey. Fire Engineering. p. 101-110.

APPENDIX A

Bangor Fire Department

1998 Organizational Chart

Fire Chief

Asst. Chief A-Crew Communications

Captain Central Station

Lt. Station 5
Rescue 5
FF Paramedic
FF EMT

Engine 5
FF
FF EMT-I
FF EMT

Lt. Central
Engine 1
FF Paramedic
FF

Ladder 1
FF
FF

Rescue 1
FF Paramedic
FF EMT

Lt. Station 6
Rescue 6
FF Paramedic
FF EMT

Engine 6
FF
FF EMT-I
FF EMT

Asst. Chief B-Crew Vehicles

Captain Central Station

Lt. Central
Engine 1
FF Paramedic
FF

Ladder 1
FF
FF

Rescue 1
FF Paramedic
FF EMT

Captain Station Six

Rescue 6
FF Paramedic
FF EMT

Engine 6
FF
FF EMT-I
FF EMT

Asst. Chief C-Crew EMS

Captain Central Station

Lt. Station 5
Rescue 5
FF Paramedic
FF EMT

Engine 5
FF
FF EMT-I
FF EMT

Lt. Central
Engine 1
FF Paramedic
FF

Ladder 1
FF
FF

Rescue 1
FF Paramedic
FF EMT

Lt. Station 6
Rescue 6
FF Paramedic
FF EMT

Engine 6
FF
FF EMT-I
FF EMT

Asst. Chief D-Crew Prevention/Ed.

Captain Central Station

Lt. Central
Engine 1
FF Paramedic
FF

Ladder 1
FF
FF

Rescue 1
FF Paramedic
FF EMT

Captain Station Five

Rescue 5
FF Paramedic
FF EMT

Engine 5
FF
FF EMT-I
FF EMT

APPENDIX B

I am currently involved in the Executive Fire Officer Program at the National Fire Academy and could use your assistance with my current research project. Your responses to the following questions will assist in my research involving "Identifying Truss Construction".

1. Does your community have a method in place that identifies buildings of Truss Construction?

   YES _____ NO _____ (if your response was "no" proceed to question # 6)

2. Which method does your community use to identify Truss Construction?

   PREPLANS _____ SIGNAGE _____ OTHER _____ (please explain) _____

3. <u>If you use a sign</u> to indicate trusses are a part of the construction does it differentiate between:

   Roof and Floor trusses? YES _____ NO _____

   Wood and Steel trusses? YES _____ NO _____

4. What authority is used to insure compliance?

   ORDINANCE _____ LOCAL BUILDING CODE _____ OTHER _____

5. Which types of buildings does your program identify as Truss Construction?

   COMMERCIAL/INDUSTRIAL _____ MULTIFAMILY RESIDENTIAL _____ ALL _____

6. Have there been any incidents of structural failure in your community involving Truss Construction?

   YES _____ NO _____ (go to the end) UNKNOWN _____ (go to the end)

7. Where any injuries associated with the structural failure?
   YES _____ NO _____ UNKNOWN _____ FATALITY _____

I want to thank you for taking the time to respond to this questionnaire and would ask you to please provide

the following information (as a minimum, please provide city and state).

Your department: _____ Your name: _____ Street address: _____ City: _____ State: _____ Zip Code:

If you would like a copy of the survey summary please indicate below:

YES _____ **NOT NECESSARY** _____

APPENDIX C

98-324

37

Assigned to Councilor Farnham August 10, 1998

CITY OF BANGOR

(TITLE.) Ordinance, Amending Chapter II, Article 14 of the Laws and Ordinances of the City of Bangor -- Fire Department (Wooden Truss)

IN CITY COUNCIL
August 24, 1998
Passed
A True Copy, Attest:
Gale E. Campbell
CITY CLERK

Be it ordained by the City Council of the City of Bangor, as follows:

WHEREAS, the City of Bangor Fire Department may become involved in handling fires within buildings or structures constructed with wooden truss roofs and floors; and

WHEREAS, wooden truss roofs and floors can present a serious risk to fire suppression personnel because of structural failure as a result of exposure to fire; and

WHEREAS, structural collapse of wooden truss roofs and floors can occur within the early stages of fire suppression activities; and

WHEREAS, numerous fire suppression personnel throughout the United States have been killed or seriously injured as a result of structural failure of wooden truss roofs and floors which have been exposed to fire; and

WHEREAS, the need exists for fire suppression personnel and incident commanders to recognize these particular construction features, during the early phases of ground operations; and

WHEREAS, the Bangor City Council has determined that a need exists for the marking of those commercial, industrial and residential structures within the City of Bangor which have wooden truss roof and floor assemblies, in order to insure the safety of Fire Department personnel,

NOW, THEREFORE, by the City Council of the City of Bangor, be it ordained

THAT Chapter II, Article 14 of the Laws and Ordinances of the City of Bangor be amended by adding a new Section 7C, to read as follows:

Sec. 7C Wood Truss Warning Sign. Subject to rules and regulations which may be prescribed by the City Fire Chief, the owner of any commercial, industrial or residential structure which has a wooden truss assembly shall be required to mount warning signs.

(1) Definitions. For the purpose of this section, the following terms, phrases and words shall have the following meaning:

A. "Sign" shall mean a five (5) inches (minimum) by four (4) inches (minimum) piece of aluminum or stainless steel stock plate 1/8 inch thick (minimum) of the preapproved design. Located at the center of the sign is a white 3M diamond grade or equivalent reflective letter "T" which is two and one half (2 1/2) inches (minimum) in height.

B. "Property owner" means any person, firm or corporation having a legal ownership interest in the property.

C. "Wooden truss" means a wooden roof or floor structure consisting of a group of triangles arranged in a single plan in such a manner that loads applied at the points of the intersections of the structural members will cause only direct stresses, tension or compression within the structural members. Wooden truss may include, but are not limited to, the following constructions: bowstring, warren, sawtooth, k truss, scissors, cambered fink, hammerbeam, pratt, fink and inverted queen posts and floor truss.

D. "Multi-Family" shall mean any residential structure having four (4) or more units that have restricted access through locked doors and have a common corridor for access to living units.

(2) Required Signage. The owner of any commercial, industrial or multi-family residential structure which has a wooden truss assembly shall be required to mount warning signs meeting the following minimum requirements:

A. Size and Construction: Each sign required to be installed in accordance with this ordinance shall be of the size and construction defined within the Definitions section.

B. Mounting Locations and Height From Finished Grade: A sign shall be mounted directly to the right of each series of entrance doors (front, rear and sides of the building or structure) at a height of five (5) feet up from finished grade. Additional signs may be required by the Fire Chief

when the distance between entrance doors or the length of a series of entrance doors would require additional warning signs for visibility by Fire Department personnel. If the property has a "knox box" on site then a sign shall be located directly above the "knox box."

(3) Property Owner Responsibility. It shall be the responsibility of each property owner to mount, maintain and prevent obstruction of any warning signs required to be mounted on the building or structure.

(4) Penalties. Whoever violates the provisions of this Article shall be subject to a fine of not less than Fifty Dollars ($50.00) nor more than Five Hundred Dollars ($500.00). Each day that said violation is permitted to exist shall constitute a separate offense.

APPENDIX D

119th MAINE LEGISLATURE

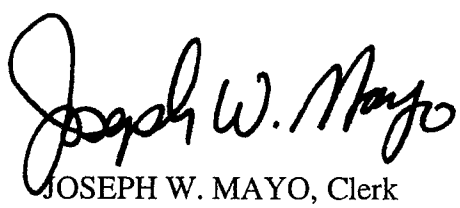
FIRST REGULAR SESSION-1999

Legislative Document **No. 2098**

H.P. 1466 House of Representatives, March 30, 1999

An Act to Improve the Safety of Firefighters.

Reference to the Committee on Criminal Justice suggested and ordered printed.



JOSEPH W. MAYO, Clerk

Presented by Representative DUPLESSIE of Westbrook.
Cosponsored by Senator DOUGLASS of Androscoggin and
Representatives: AHEARNE of Madawaska, BERRY of Livermore, DUDLEY of Portland, MAILHOT of Lewiston, McALEVEY of Waterboro, SANBORN of Alton, SAXL of Bangor,
Senator: RAND of Cumberland.

Be it enacted by the People of the State of Maine as follows:

Sec. 1. 25 MRSA §§2466 and 2467 are enacted to read:

§2466. Emblem for truss construction

1. Definitions. As used in this section, unless the context otherwise indicates, the following terms have the following meanings.

A. "Emblem" means a sign of a minimum size of 5 by 4 inches constructed of aluminum or stainless steel stock plate with a minimum thickness of 1/16 inch. A white diamond grade or equivalent reflective capital letter T must be located at the center of the sign. This letter must have a minimum height of 2 1/2 inches. A diagram of a truss must be placed on the sign in accordance with the directions listed in this paragraph. The diagram of a roof truss must be similar to 2 capital letter Ws placed side by side and connected to each other with a heavy or dual line drawn across the top and bottom of the capital letter Ws to create a drawing of a simple cord truss. The diagram for a floor truss must be similar to a capital letter V with a heavy or dual line drawn across the top and bottom of the capital letter V to create a drawing of a simple cord truss.

(1) For structures where a truss or trusses are used in the roof construction, a diagram of a roof truss must be placed across the top of the reflective capital letter T.

(2) For structures where a truss or trusses are used in the floor construction, the diagram of a floor truss must be placed across the bottom of the capital letter T.

(3) Structures using a truss or trusses in both roof and floor must have the diagram of a roof truss placed across the top and the diagram of a floor truss placed across the bottom of the capital letter T.

(4) When the truss material is made of wood, there must be a circle that is one inch in diameter placed alongside the capital letter T on the left-hand side. This circle must be of the same color and material as the capital letter T.

(5) When the truss material is made of metal or steel, there must be a circle that is one inch in diameter placed alongside the capital letter T on the right-hand

side. This circle must be of the same color and material as the capital letter T.

(6) If both materials are used in any of the truss construction, then the circles that are one inch in diameter must be placed on both sides of the capital letter T.

B. "Planned real estate development" or "development" means any real property situated within the State, whether contiguous or not, that consists of or will consist of separately owned, leased or rented areas, irrespective of form, including lots, parcels, units or interest, is offered or disposed of pursuant to a common promotional plan and provides for common or shared elements or interests in or use of real property.

C. "Truss" means a roof or floor structure or a partial roof or floor structure consisting of a group of triangles arranged in such a manner that loads applied at the points of the intersections of the structural members will cause only direct stresses, tension or compression within the structural members. Trusses may include but are not limited to the following constructions: bowstring; warren; sawtooth; scissors; cambered fink; hammer beam; pratt; fink; inverted queen posts; and floor truss.

2. Emblem required. Except as provided in subsection 3, an emblem must be affixed to a structure with a truss or trusses used in the construction or partial construction of roof or floor structures. The emblem must be permanently affixed to the left of the main entrance of the structure and at each series of entrance doors at a height between 4 to 6 feet above the ground. Additional emblems may be required by the fire chief for the jurisdiction in which the building is located when the distance between entrances or the length of a series of entrances necessitates additional emblems for visibility for fire departments. The owner of the structure shall install and maintain the emblem.

3. Exceptions. Subsection 2 does not apply to:

A. Detached one-family and 2-family residential structures with truss construction built before the effective date of this section that are not part of a planned real estate development; however, the governing body of a municipality may require by local ordinance that emblems be affixed to these structures; and

B. Individual structures and dwelling units with truss construction that are part of a planned real estate development, as long as an emblem is affixed at each entranceway to the development.

4. Violation. A violation of this section is a Class E crime.

§2467. Voluntary program for identification of hazardous and vacant buildings

1. Voluntary program. A governing body of a municipality may adopt the program established in this section to provide a uniform method to identify hazardous or vacant buildings to lessen the frequency and severity of injuries that can occur in these buildings, especially in the course of fighting fires.

2. State standard; elements. The program is the recommended state standard and includes the physical posting by a fire department within a municipality that adopts the program of vacant buildings that may be hazardous.

3. Posting requirements. Postings must consist of a sign or poster 2 feet square with a reflective background that is readily visible from the street. Posting must be located on the front of the building at or above the 2nd floor level and between openings. Postings may not be located over doors, windows or other openings, where they may be obscured by smoke or fire. All markings on the postings must be readily visible from the street and, if determined necessary by the fire department, markings must be located on the sides and or rear of the building as needed. In addition, a posting must be located adjacent to all entrances and on penthouses.

A posting of a vacant building must contain one of the following symbols.

A. A vacant building that has interior hazards to such a degree that interior fire-fighting operations must be conducted with extreme caution is indicated by a square that has a diagonal line running from the top right-hand corner to the bottom left-hand corner.

B. A vacant building from which fire-fighting operations must be conducted from the exterior of the building is indicated by a square that has 2 crossed diagonal lines, one running from the top right-hand corner to the bottom left-hand corner and one running from the top left-hand corner to the bottom right-hand corner.

SUMMARY

This bill requires structures that use trusses in the floor or roof or parts of the floor or roof to display an emblem on the building signifying that construction and the materials used in the truss construction. The purpose is to increase the protection to firefighters by informing them that trusses are present. A violation for noncompliance is a Class E crime.

The bill also provides a voluntary statewide recommendation for a uniform program of identifying dangerous or vacant properties to further protect firefighters.

APPENDIX E

SUMMARY OF TRUSS IDENTIFICATION SURVEY

To obtain a clear picture of the methods and programs, utilized by the other fire service organizations to identify the trusses in their community, a truss identification survey was developed. This survey was distributed to all the students present at the National Fire Academy and the Emergency Management Institute during the last week of March 1999. The survey sheet was circulated to those attending the International Association of Firefighter's emergency medical services conference in San Francisco, California, May 4-9, 1999. The survey was also distributed to those connected with the fire service at the International Association of Arson Investigator's conference in Las Vegas, Nevada in May 17-21, 1999.

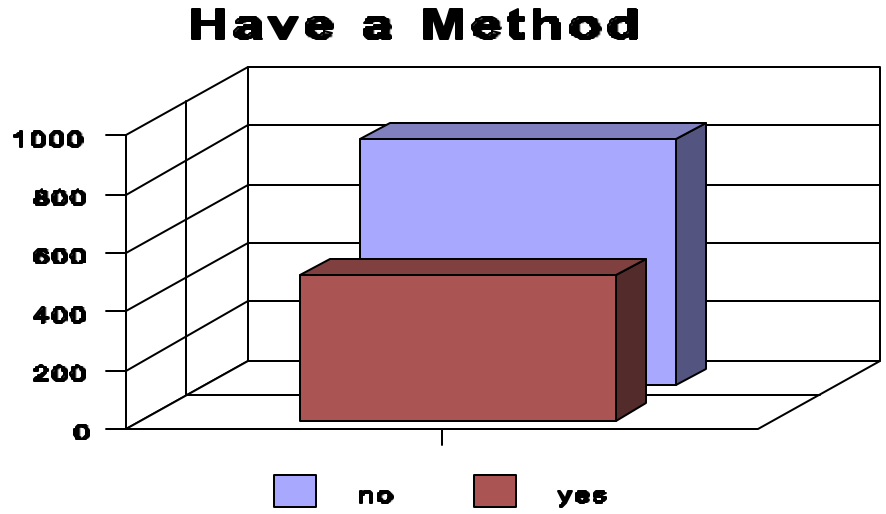
Survey sheets were also mailed to individuals taken from previously attended NFA class rosters in states not previously contacted. In a three-month period a total of 1,500 surveys were distributed with 1, 333 or 89% returned. Organizations were contacted representing all fifty states, however, responses were only received from agencies located in 47 states.

The survey asked the participants to respond to a series of questions regarding their department's method used to identify trusses in their community. Each participant was asked to answer seven questions. The first question was used to place the respondents in one of two categories. The first category was for those who responded that they had a program in place to identify truss construction. There was a subset within this group of respondents who indicated that they used a warning sign in their program. The second category was for those who responded that they did not have a program. Most questions allowed the respondents to simply check a box to indicate their response. Results, which were tabulated by question and listed in a percentage format are presented herein:

1. Does your community have a method in place that identifies buildings of Truss Construction?

YES **493** NO **840** (If your response was "no" proceed to question # 6)
PERCENT ..... 37% 63%

GRAFT #1



Graft #1

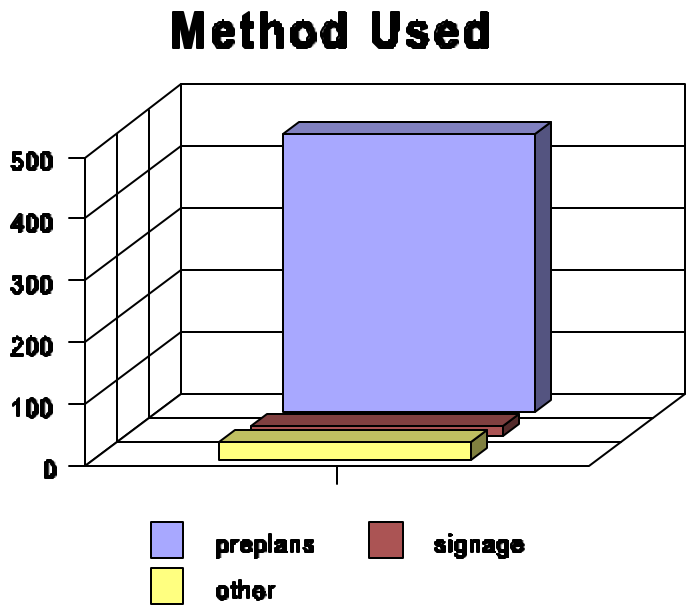
illustrates that 37% of the respondents have a method they use to identify buildings of truss construction. It also shows that 63% of the respondents indicated they do not have a program in place to identify trusses in their community.

Questions two through five applied only to 493 or 37% of the respondents that indicated they have a program in place.

2. Which method does your community use to identify Truss Construction?

PREPLANS **449** SIGNAGE **16** OTHER **28** (please explain)
PERCENT ..... 91% ..... 3% 6%

GRAFT #2



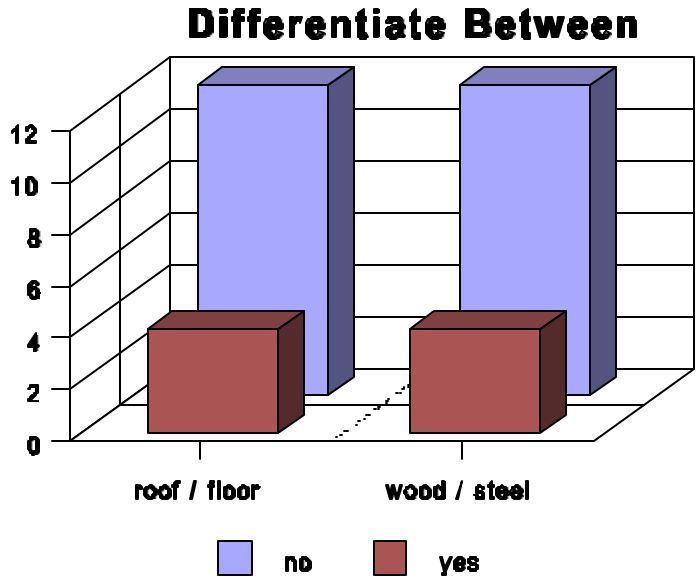
Graft #2 shows a breakdown of the respondents as to the method used to identify truss construction. Ninety-one percent the respondents use preplans, 3% use warning signs, and the remaining 6% indicated they use another method. Some of those who indicated the "other" method listed onboard computer system, data base system, and CIDS as their means of identification. It should also be noted that 11 out of the 16 respondents that indicated they use signs were from varying departments in New Jersey.

3. <u>If you use a sign</u> to indicate trusses are a part of the construction does it differentiate between:

Roof and Floor trusses? YES **4** NO **12**
PERCENT ..... 25% 75%

Wood and Steel trusses? YES **4** NO **12**
PERCENT ..... 25% 75%

GRAFT #3

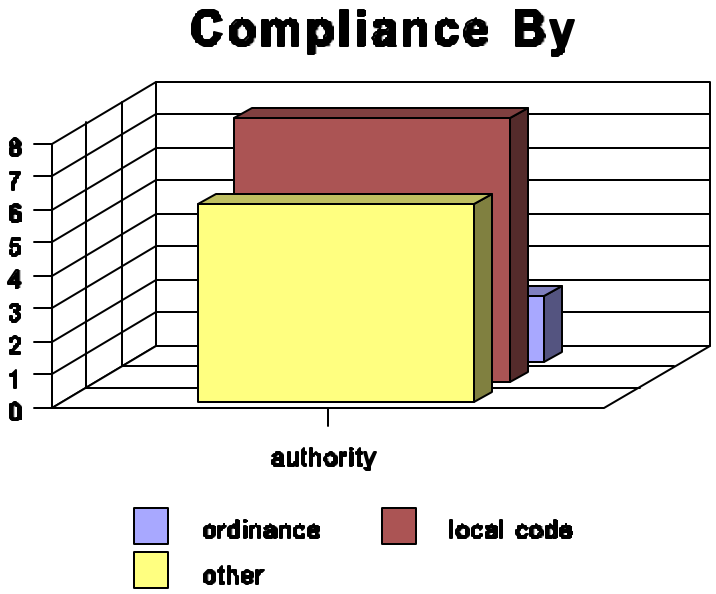


In graft #3, 25% of the respondents indicated that their program differentiated between roof and floor trusses, as well as, wood and steel systems. This meant that the system used by the remaining 75% did not provide that information to them.

4. What authority is used to insure compliance?

ORDINANCE **2** LOCAL BUILDING CODE **8** OTHER **6**
PERCENT ..... 13% ..... 50% 37%

GRAFT #4

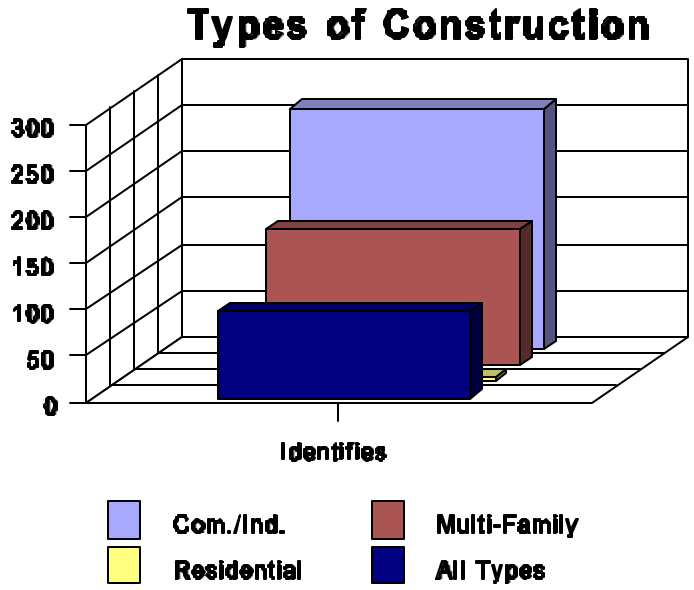


Graft #4 illustrates that only 13% of the respondents use ordinances to insure compliance. Fifty percent of the respondents indicated that their system utilizes their local building codes. Those who indicated they use "other" comprised 37% of the responses. Five out of the six respondents in the "other" category indicated the system used. Two indicated they use company inspections, two respondents stated voluntary compliance was used, and the last one indicated they utilized the required certificate of occupancy to insure compliance.

5. Which types of buildings does your program identify as Truss Construction?

COM../IND. **260** MULTI-FAMILY **146** RESIDENTIAL **4** ALL **93**
PERCENT ..... 50% ..... 30% .....1% 19%

GRAPH #5

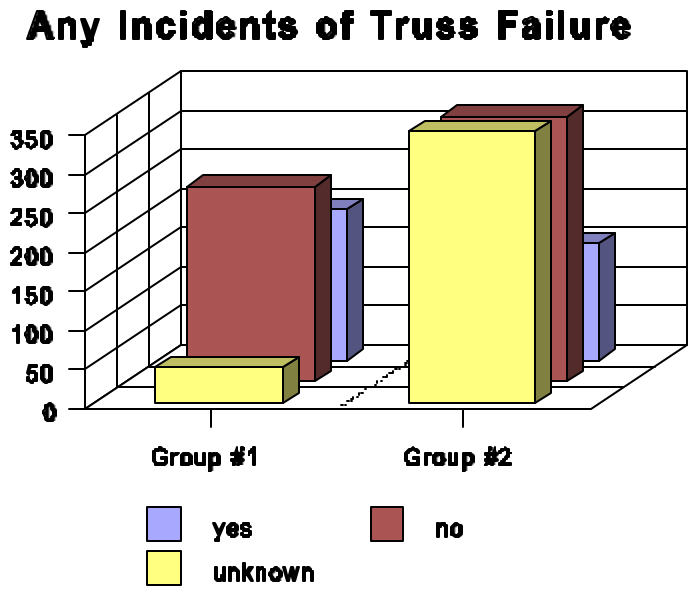


A breakdown of the type of construction the respondent's truss identification program applies to is provided in graft #5. This graft clearly illustrates that 50% of the programs surveyed apply to commercial and industrial structures. Thirty percent of the programs would apply to multi-family housing. The "all types" category was indicated by 19% of the respondents, whereas the residential category was indicated by only 1%. This last category (residential) may require closer scrutiny. It could be assumed that since 19% of the respondents indicated their program applied to all types, and only 1% indicated that their system applied to residential, that the real number is most probably closer to 19 or 20%.

6. Have there been any incidents of structural failure in your community involving Truss Construction?

YES **348** NO **440** (go to the end) UNKNOWN **387** (go to the end)
PERCENT..... 31% ..... 39% 30%

GRAPH #6



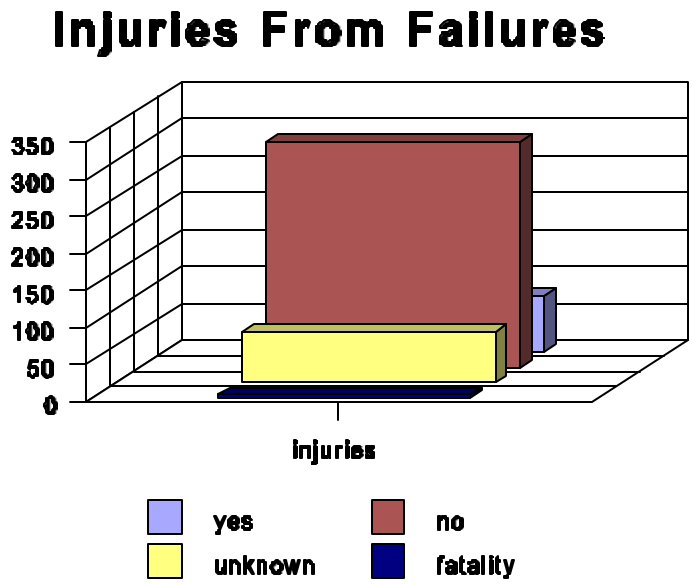
In graph #6 there are two groups identified. This refers back to the first question of the survey where all the respondents that answered "YES" were placed in the first group. It was surprising to discover the number of incidents indicating some negative experience with truss failure was so high, yet the actual number of programs to identify truss construction was rather low. It should be noted that 158 or approximately 12% of the respondents failed to answer this question.

In the first group 40% of the respondents indicated they had experienced structural truss system failure. Fifty-one percent stated no previous failures and the remaining 9% did not know of any truss system failures. The second group's numbers showed a marked difference. Only 18% of the respondents indicated their departments had an incident of truss failure. Forty percent selected no incidents and the remaining 42% indicated it was unknown if their community had experienced a failure.

7. Where any injuries associated with the structural failure?

YES **76** NO **304** UNKNOWN **68** FATALITY **4**
PERCENT ..... 17% ..... 67% ..... 15% 1%

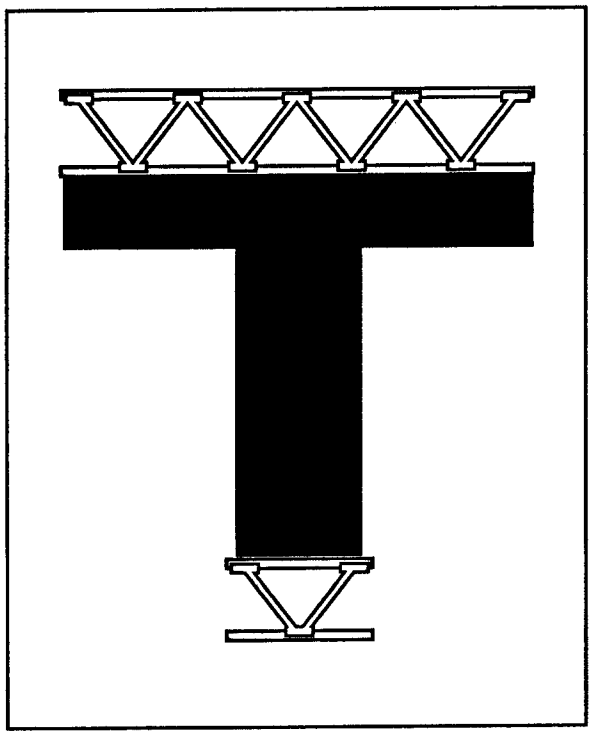
GRAPH #7



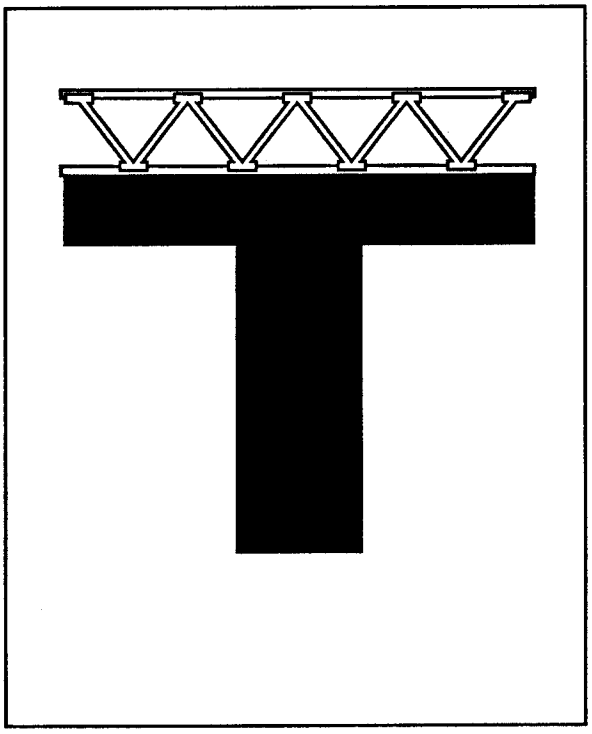
Graft #7 illustrates that 17% of the respondents indicated that their organization had experienced injuries to their personnel associated with structural failure from truss construction. One percent indicated their department had suffered the lost of a firefighter. The vast majority, which comprised 67% of the respondents, indicated that no injuries were sustained. The remaining 15% did not know of any injuries in their reported truss failures.

APPENDIX F

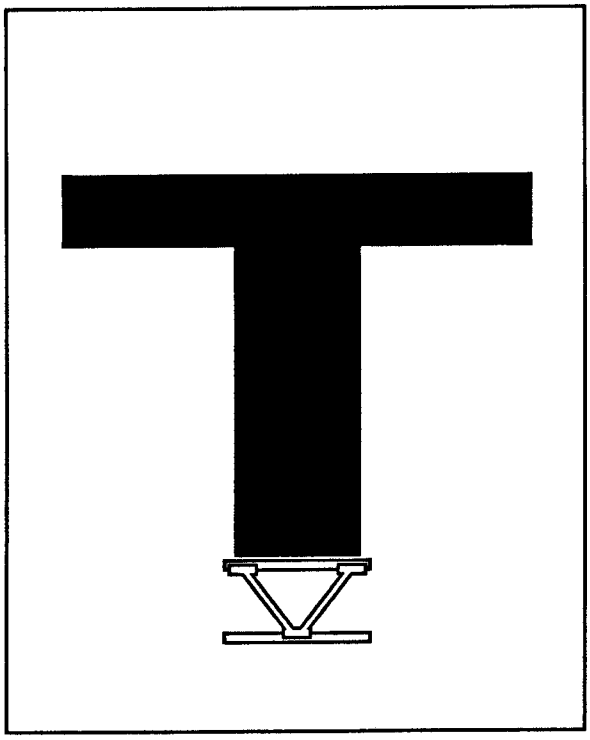
Appendix 1: Simple Truss Panels



Panel **TNL1-T/T** shows that this building has a truss in the roof and also in the floor.



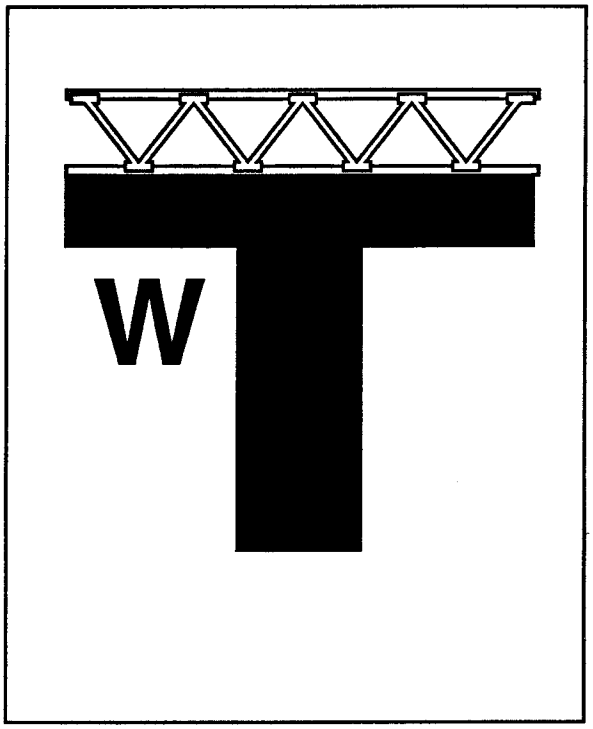
Panel **TNL2-T/X** shows that this building has a truss in the roof.



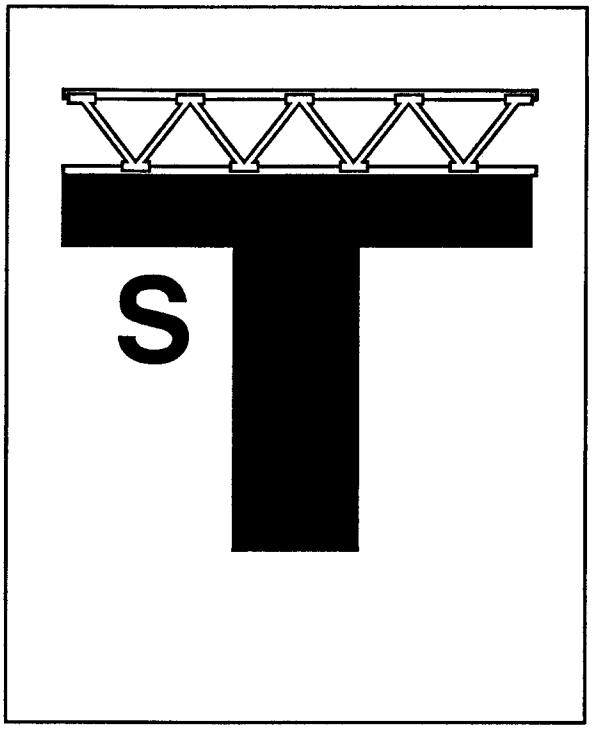
Panel **TNL3-X/T** shows that this building has a truss in the floor.

All representations of Truss Safe-T Panels in these appendices are reduced to 75% of their actual size.

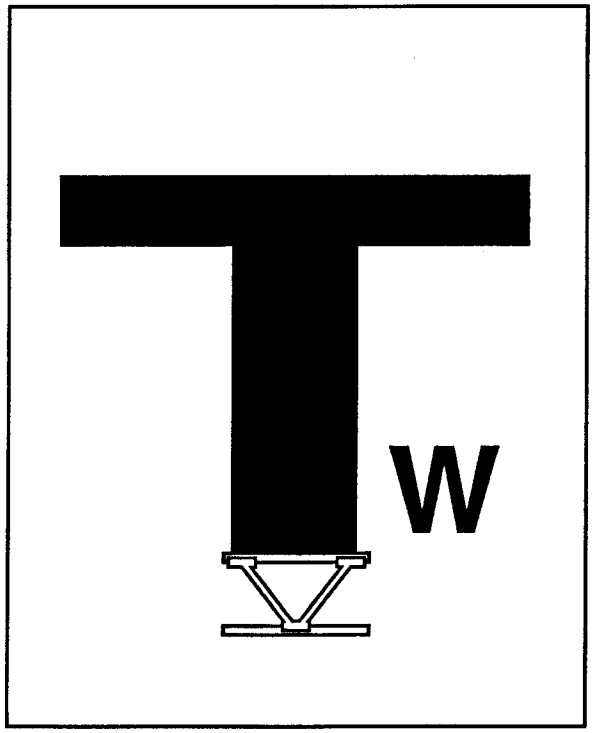
Appendix 2: Truss Panels with Material Indication



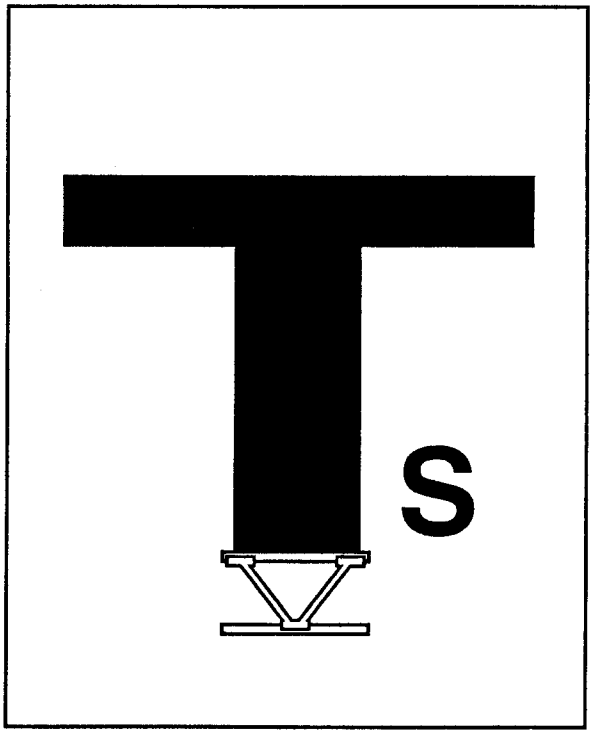
Panel **TMS5-WT/X** shows that this building has a wood truss in the roof.



Panel **TMS6-ST/X** shows that this building has a steel truss in the roof.

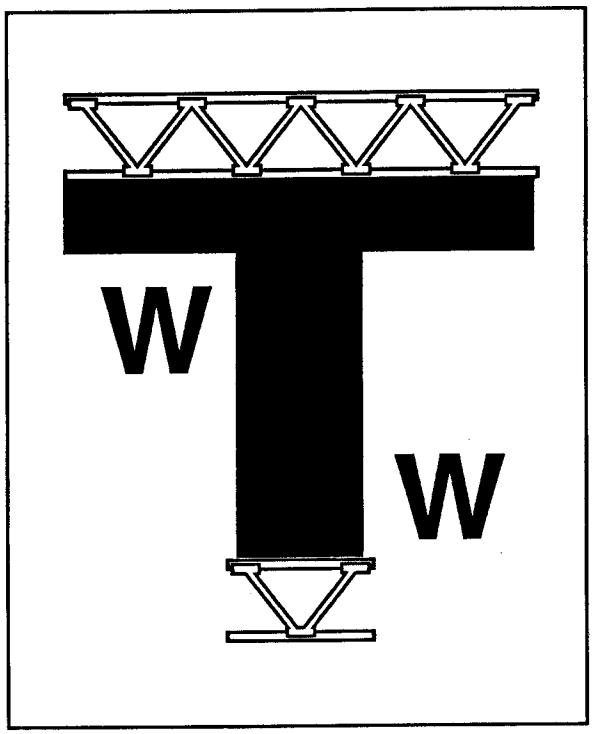


Panel **TMS7-X/WT** shows that this building has a wood truss in the floor.

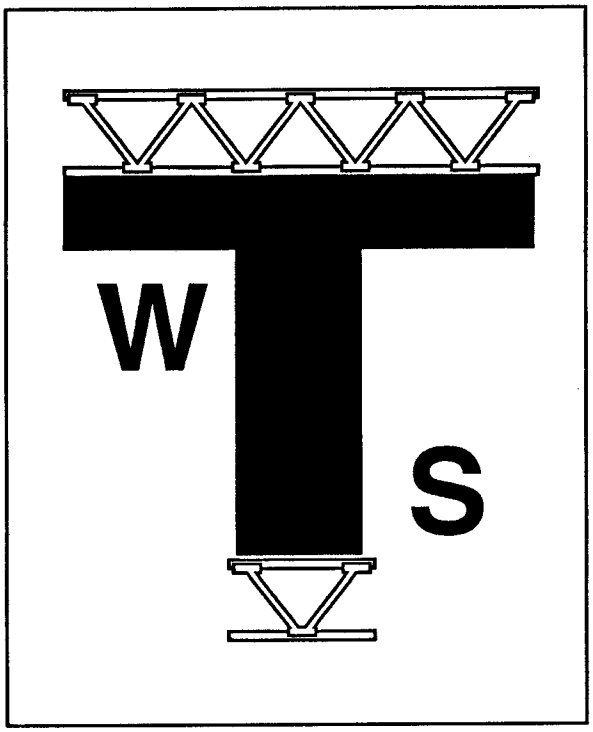


Panel **TMS8-X/ST** shows that this building has a steel truss in the floor.

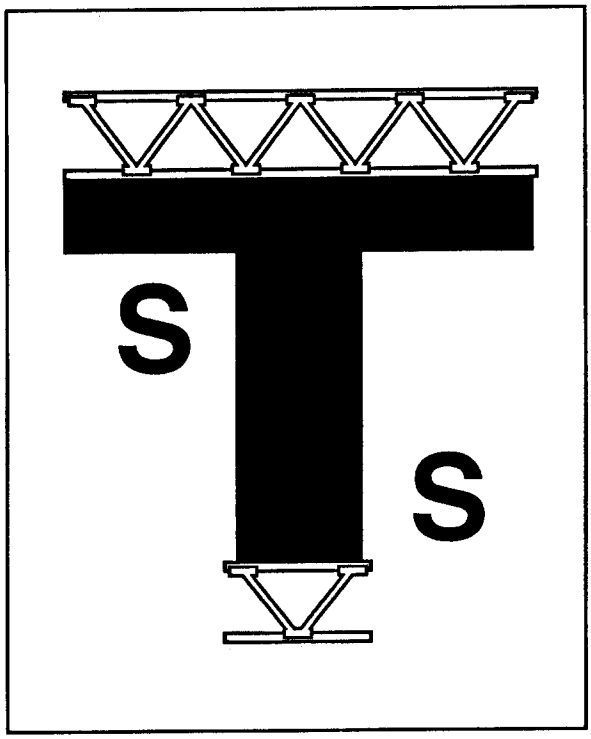
Appendix 2: Truss Panels with Material Indication



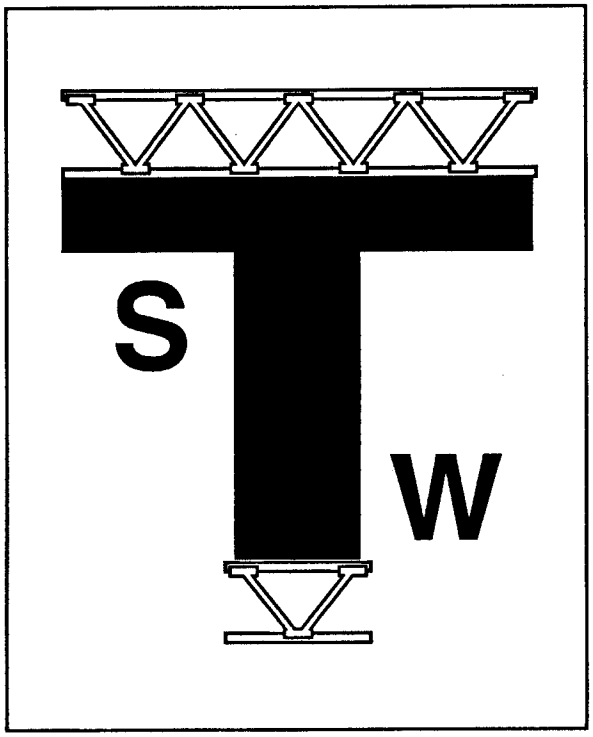
Panel **TMS1-WT/WT** shows that this building has a wood truss in the roof and the floor.



Panel **TMS2-WT/ST** shows that this building has a wood truss in the roof and a steel truss in the floor.



Panel **TMS3-ST/ST** shows that this building has a steel truss in the roof and the floor.



Panel **TMS4-ST/WT** shows that this building has a steel truss in the roof and a wood truss in the floor.